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Docket No.: 6727/1H841

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Israel Lifshitz et al.

Serial No.: 09/699,214 Art Unit: 2122

Filed: October 27, 2000 Examiner: To be assigned

For: EFFICIENT FRAMING FOR ADSL TRANSCEIVERS

- -

CLAIM FOR PRIORITY

Hon. Commissioner of
Patents and Trademarks
Washington, DC 20231

Sir:

Applicant hereby claims priority under 35 U.S.C. Section 119 based on Israel application No. Application No. 132638 filed October 28, 1999.

A certified copy of the priority document is submitted herewith.

Respectfully submitted,

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Reg. No. 25,351
Attorney for Applicant(s)

Dated: January 19, 2001

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16-11-2000

This היום

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132638	מספר: Number
28-10-1999	תאריך: Date
	הוקדם/נדחה Ante/Post-dates

חוק הפטנטים, התשכ"ז -- 1967
PATENTS LAW, 5727-1967

בקשה לפטנט
Application for Patent

C:35861

אני, (שם המבקש, מענו -- ולגבי גוף מאוגד -- מקום התאגדותו)
I (Name and address of applicant, and, in case of body corporate-place of incorporation)

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(An Israeli company)

(חברה ישראלית)

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Owner, by virtue of By Law of an invention, the title of which is:

(בעברית) (Hebrew) שיטה והתקן למסגור יעיל במקלט/משדר ADSL

(באנגלית) (English) METHOD AND APPARATUS FOR EFFICIENT FRAMING FOR ADSL TRANSCEIVERS

hereby apply for a patent to be granted to me in respect thereof
מבקש בזאת כי ינתן לי עליה פטנט

*בקשה חלוקה - Application for Division	*בקשת פטנט מוסף - Application for Patent of Addition	*דרישה דין קדימה Priority Claim		
מבקשת פטנט from Application	*לבקשה/לפטנט to Patent/Appl.	מספר/סימן Number/Mark	תאריך Date	מדינת האיגוד Convention Country
No. ____ מס.	No. ____ מס.			
dated ____ מיום	dated ____ מיום			

*יפוי כח: כללי/מיוחד - רצוף בזה / עוד יוגש
P.O.A.: general / individual - attached / to be filed later -
filed in case ____ הוגש בענין

המען למסירת הודעות ומסמכים בישראל
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חתימת המבקש
Signature of Applicant

For the Applicant,

Sanford T. Colb & Co.
C:35861

היום 28 בחודש October שנת 1999
This 28 of October of the year 1999

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שיטה והתקן למסגור יעיל במקלט/משדר ADSL

METHOD AND APPARATUS FOR EFFICIENT FRAMING FOR ADSL TRANSCEIVERS

ORCKIT COMMUNICATIONS LTD.
C: 35861

אורכית תקשורת בע"מ

Method and Apparatus for Efficient Framing for ADSL Transceivers

FIELD OF THE INVENTION

This invention relates to digital transmission systems, and in particular, to a method and apparatus of efficient framing for ADSL modems.

BACKGROUND OF THE INVENTION

ADSL links are typically connecting a central office to resident houses. An important goal of ADSL, is to cover a large percentage of customers who belong to the central office. ADSL is rate adaptive, and the rate is determined according to the noise condition and the length of the line. Consequently, customers located far from the central office are limited to low bit rates, and some far customers cannot get a minimum service at all. What is desired, therefore, is a method to improve the performance an ADSL modem for low rates and high reaches, in order to increase the coverage.

ADSL framing was defined in T1.413 [T1E1 committee, T1.413 issue2 from the 4 December 1998] and in G.DMT [G992.1 from July 1999]. These standards include a significant constant overhead, which limits the service for long lines (we shall refer to these documents as the "ADSL standards"). The framing is based on DMT symbols. A DMT symbol is a mapping of a fixed number of bits (denoted as L) to sine waves of multiple frequencies. The number L is determined according to the line, and is typically low for long and noisy lines.

A standard ADSL framer receives payload bytes, assembles them in groups, and then concatenates a payload group with S overhead bytes, and appends a Reed-Solomon parity, in order to produce a Reed-Solomon code word of N bytes. Then, the codeword is divided to S equal parts of L bits. Each part is mapped to a DMT symbol. For long lines, L is small, and therefore the percentage of the overhead is large. Different methods for improving the framing where presented in the ITU-T, and are available at the ITU-T Internet site. These methods are based on reduction of the number of overhead bytes per code word, keeping an integer number of bytes per symbol. The implication is that if the optimal number of bits per DMT symbol (L) is not a multiple of eight, up to seven bits can be wasted. This implied overhead is significant, and was overlooked in prior art.

In addition, the ADSL standard defines a super frame, which comprises 68 DMT symbols which carry data, and a single additional DMT symbol which is used for synchronization (the "sync symbol"). These symbols are numbered, and each of them is related to a single overhead byte. That is, a super-frame always comprises of 68 overhead bytes. For low rates, a superframe caries a low number of bits (total of 68*L bits), and the percentage of overhead bits is large. Suggestions were made to reduce the overhead by changing of the number of overhead bytes in a super frame. This approach complicates the backward compatibility with the current ADSL standards. A method is desired to keep the backward compatibility and numbering of overhead bytes on one hand, and reduce the percentage of overhead on the other hand.

SUMMARY OF THE INVENTION

According to the present invention, the concept of integer number of bytes is transferred from a DMT symbol to a new entity denoted as "overhead-frame". That is, we define a frame which contains an integer number of bytes, while the number of bits per DMT symbol can be different from a multiple of eight. An overhead-frame includes a fixed number of DMT symbols, which is denoted as Q. For Q which is a multiple of 8, the number of bits per DMT symbol (L) is not restricted, and the overhead is reduced. An overhead frame also includes a fixed number of overhead bytes.

In addition, in order to preserve backward compatibility to the current ADSL standards, this invention defines a "hyper frame" which comprises an integer number (P) of super frames. The overhead bytes in a hyper frame are numbered 0 to 67. Each overhead byte can preserve its function according to the current ADSL standard. This scheme therefore reduces the overhead by a factor of P, and at the same time, preserves the structure and functionality of the overhead bytes.

In addition, this invention facilitates direct support of different rates without the stuff-rob mechanism, which is defined in the ADSL standards. This is achieved due to the fact that the number of bits in a DMT symbol (L) is not limited.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Other features of the invention, as well as the invention itself will become more readily apparent with reference to the following detailed description taken together with following drawings, in which:

Fig. 1 describes a typical ADSL apparatus for implementation of the invention
Fig. 2 illustrates an example of an overhead frame, and its partition to DMT symbols
Fig. 3 is an example of an overhead frame, which is typical for an embodiment of the invention for non-standard rates without the use of a standard stuff-rob method.
Fig. 4 is an example of a hyper frame, and its partition to super frames.

Figure 1 describes a best mode implementation of the invention. The framer 200 in figure 1 receives a stream of information payload bits. It then assembles the bits into bytes, and adds overhead bytes in predetermined locations. The Reed-Solomon encoder 210 adds redundancy bytes to the frame, and thus produces a overhead frame. In this implementation of the invention, the overhead frame is also a Reed-Solomon code word. The code word is then processed by an interleaver 220 and a constellation encoder 230, both defined by the ADSL standards. All these blocks can be implemented by hardware or software, using similar technologies to the ones used for standard ADSL.

Figure 2 describe the overhead frame at the output of the Reed-Solomon encoder 210, which comprises overhead bytes 150, payload bytes 160 and redundancy 170. Figure 2 also describes the mapping of the overhead frame 100 to DMT symbols 110. The overhead frame in this example spans over 16 DMT symbols 110, the number of bits per DMT symbol (L) is 30 (3.75 bytes), and the total number of bytes in the overhead frame is 60. This mapping is carried out by the constellation encoder 230. For the

sake of clarification, the interleaver is transparent in this example. However, its operation is straightforward, and is explained in the ADSL standards.

FIG. 3 is an example of using the invention to support a non-standard data rate of 1544 kHz without the use of the standard stuff-rob mechanism. This is the rate of a DS1 service. In this example, the number of bits per DMT symbol 110 is L=420 (52.5 bytes). The overhead frame 100 comprises a single overhead byte 150, 16 redundancy bytes 170, and payload blocks 160 of 386 bits each. In this embodiment of the invention, the ADSL clock can be synthesized from a reference clock which is available at the central office and synchronized to the DS1 stream, and the payload bits can be transferred to the remote unit over ADSL, exactly at the rate of 1544kHz.

FIG. 4 describes a hyper-frame 190 which include 4 Super frames 180. In the best mode implementation, the framer 200 inserts the overhead bytes in the order defined by the ADSL standards, resulting in 68 overhead bytes per hyper frame (the overhead bytes are not shown in the figure). The first Super frame includes overhead bytes numbered from 0 to 16, the second Super frame includes overhead bytes numbered from 17 to 33, the third Super frame includes overhead bytes numbered from 33 to 50, and the fourth Super frame includes overhead bytes numbered from 51 to 68. The hyper-frame which is illustrated at figure 4 is produced at the output of the Reed-Solomon encoder 210 of figure 1.

Although preferred embodiments are described hereinabove with reference to ADSL, it will be appreciated that the principles of the present invention are applicable to other modulation schemes, as well, such as VDSL.

CLAIMS

1. A method for framing input data for transmission, comprising:

grouping an integer number of bytes of the input data in an overhead frame: and

mapping the data in the overhead frame into DMT symbols, wherein each symbol corresponds to a number of bits of the input data that is not a multiple of eight.

2. A method according to claim 1, wherein the overhead frame comprises a Reed-Solomon codeword.

3. A method according to claim 1 or 2, wherein mapping the data comprises mapping data at a rate that is not provided as a standard for ADSL transmission without use of a stuff-rob mechanism, by synthesizing an ADSL clock from a reference clock available at a central communication office.

4. A method for framing input data for transmission, comprising:

grouping an integer number of bytes of the input data in a hyper-frame, which includes multiple super frames and a constant number of overhead bytes; and

mapping the data in the hyper-frame into DMT symbols.

5. A method according to claim 4, wherein there are 68 overhead bytes in each hyper-frame, having a functionality similar to the function of standard ADSL overhead bytes.

6. Apparatus for framing input data for transmission, comprising:

a framer, which groups an integer number of bytes of the input data in an overhead frame;

a Reed-Solomon encoder, which generates a codeword based on the overhead frame; and

a constellation encoder, which maps the data in the overhead frame into DMT symbols, wherein each symbol corresponds to a number of bits of the input data that is not a multiple of eight.

For the applicant,

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C: 35861

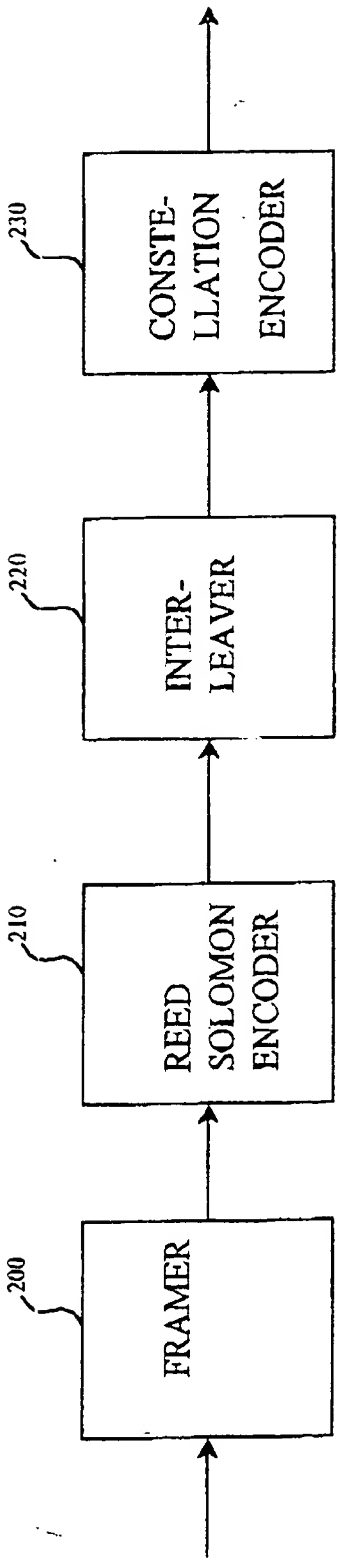
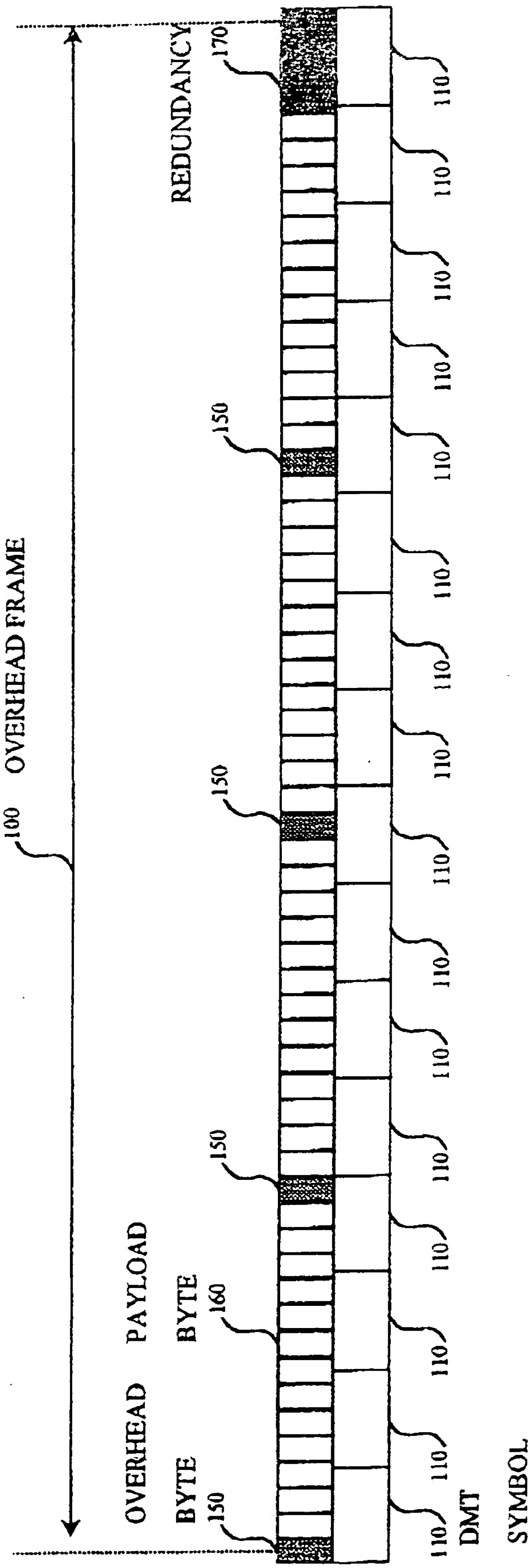

200
FRAMER
210
REED
SOLOMON
ENCODER
220
INTER-
LEAVER
230
CONSTE-
LLATION
ENCODER

FIG 1



REDUNDANCY
170
150
150
100
OVERHEAD FRAME
150
PAYLOAD
BYTE
160
OVERHEAD
BYTE
150
110
DMT
SYMBOL

FIGURE 2

FIG 3

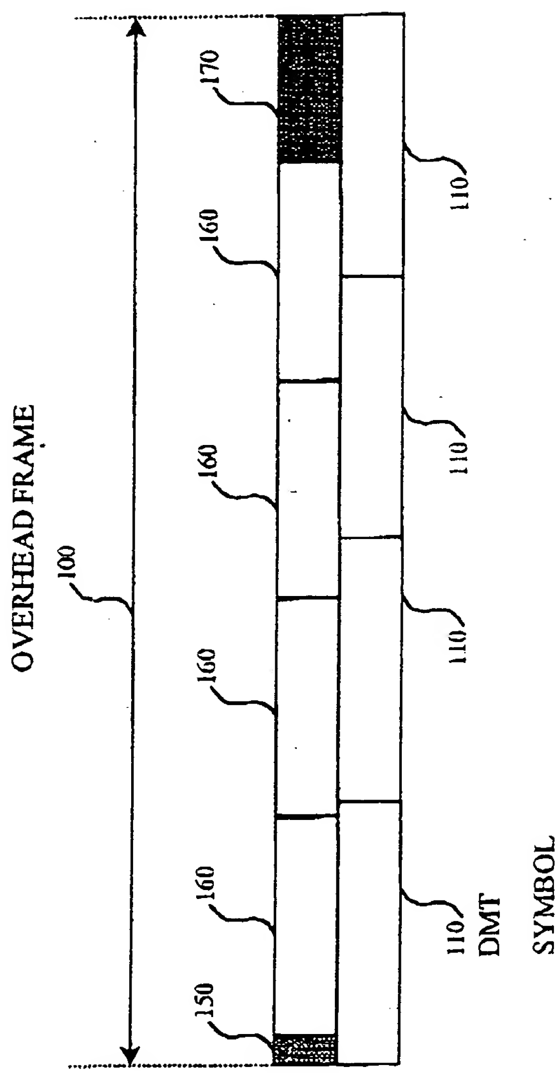
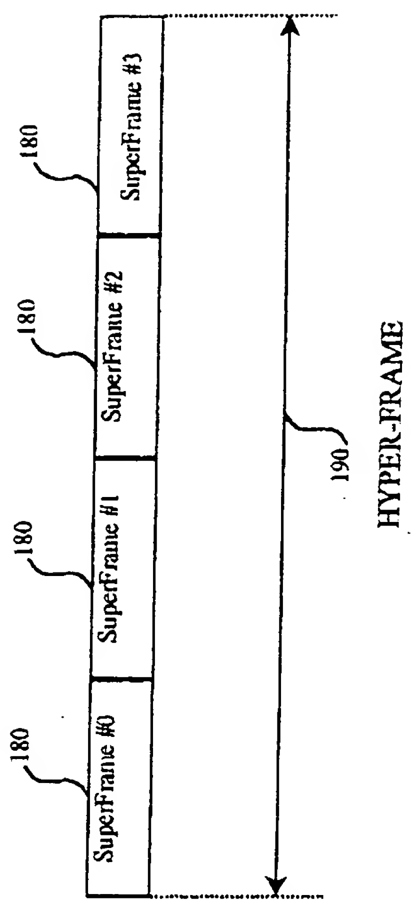

OVERHEAD FRAME
100
170
160
160
160
160
150
110
110
110
110
DMT
SYMBOL

FIG 4



SuperFrame #0
SuperFrame #1
SuperFrame #2
SuperFrame #3
180
180
180
180
190
HYPER-FRAME